A MUSEUM FOR INDIA AND THE COLONIES

AT the meeting of the International Congress of Orientalists in London in 1874, Dr. Forbes Watson read a paper in which he described (see NATURE, vol. x. p. 421) the plan of an Indian Museum, Library, and Institute. This paper was afterwards published (see NATURE, vol. xi. p. 413). Dr. Watson has just published a pamphlet[1] in which the proposed India Museum and Institute has very naturally expanded into an Imperial Museum for India and the Colonies. What Dr. Watson proposes is that on the site of the old Fife House, on the Victoria Embankment, at the Thames end of the new Northumberland Avenue, a large and suitable building should be erected, to consist of two divisions, one devoted to the interests and products of India, and the other to those of the various British Colonies. The library and collections which already exist in connection with India are acknowledged to be of great value and importance, and their location in an appropriate building in a central position would greatly increase their usefulness. The arrangement at South Kensington is of course only temporary. Now that Dr. Watson has proposed a plan for an institution which would do for the other colonies what the India Museum and Library attempt to do for India, one wonders why steps have not been taken long ago to supply what appears to be a real want. The subject has, however, engaged for years the attention of those who take an active interest in the Colonies, and several of the Colonies have gone so far as to vote money for the establishment of a Colonial Museum in London. Few people realise the importance of the Colonies to Britain; their extent, population, and the value of their commercial transactions are forcibly exhibited by Dr. Watson in his pamphlet, which we would recommend those to read who wish to have some idea of the value of the Colonies to the mother country. From a scientific point of view such an institution as is proposed would be of great interest and value. British Colonies are to be found everywhere over the surface of the globe, and embrace all climates and every variety of natural productions. Students of natural science would find a properly arranged collection of our colonial productions of great use, especially if combined with a proper library, and no better method could be devised of educating the public generally as to the extent, importance, physical condition, and natural products of "Greater Britain."

Dr. Watson shows that from every point of view, political, commercial, and scientific, the establishment of such an all-embracing Imperial Institute would be of the greatest benefit both to this country and her Colonies, and would no doubt serve to bind them more closely together. We are sure his scheme needs only to be known in its details to recommend itself to the public, and we are confident that if steps were taken to move the proper quarter, the accomplishment of the scheme would be only a question of time. The Colonies themselves are willing to bear a share of the expense necessary, and it would only be fair that this country, through the Government, should meet the Colonists as far as it can.

Into the details of Dr. Watson's plan we have not space to enter. There would, as we have said, be virtually two museums under one building. In the division devoted to the extra-India Colonies, the museum representative of each Colony would be kept distinct, so that the whole would be rather a federation of museums than one museum. Then there would be a Colonial Library and Reading-room; provision would be made for giving a home in the Institution to the Asiatic Society and the Colonial Institute; by means of "Trade Museums," a full representation would be given of Colonial produce, and in the proposed institution the offices of the various Colonial agents now dispersed over London could be established. The advantages of such an Institution are well summed up by Dr. Watson in the following paragraph:—

"The combined India and Colonial Museums, established according to the above plan, would in every way become a living institution worthily representing the past history and the present resources of the British Empire throughout the world. Such an institution would afford not only exhaustive materials for study and research, but would likewise be suitable for reference by the Indian and Colonial authorities, by men of business or of letters, and by officials or emigrants intending to proceed to India or the Colonies. Thus it would be instrumental in furthering actual work or business, whether scientific, political, or commercial. At the same time, through its co-operation with the Asiatic Society and the Colonial Institute, through its reading-room, its lectures and publications, through the Trade Museums and other typical collections distributed all over the country, as well as throughout the most important places in India and the Colonies, all the information would be rendered available to the whole Empire."

[1] "The Imperial Museum for India and the Colonies." By J. Forbes Watson, M.D., &c., Director of the India Museum. (Allen and Co.)

FERTILISATION OF FLOWERS BY INSECTS[1]

XIV.

Flowers Fertilised by the Wings of Butterflies.

IN my former articles many plants are referred to which are fertilised by butterflies, whose proboscis, head, legs, or whole underside comes into contact with the anthers and stigmas of the flowers visited; but hitherto no plant has been known which is fertilised by the fluttering wings of butterflies. My brother, Fritz Müller (Itajahy, Prov. St. Catharina, Brazil), has lately observed a species of *Hedychium* (Piperaceæ) whose bright red scentless flowers, opening in the morning, are wonderfully adapted to this manner of fertilisation. I give his description, as far as possible, in his own words.

The flowers of this Hedychium are collected in groups of 4–6, which are enveloped by a common bract; in every group only one flower is ever developed at the same time, this commonly fading before the next one has opened. The groups of flowers are arranged in alternating whorls, each consisting of three groups (Fig. 89); the spike thus formed reaches 0·25 metre in length, and is composed of six longitudinal rows of flowers, each row containing about ten.

The corolla-tubes, about 0·03 m. long, 0·5 and 1 mm. wide, are completely enclosed by the very firm common bract; moreover, each by its calyx closely embracing it, by its special bract and partly by the bracts of the older flowers of the same group. Thus the honey, which on the morning of the first day fills up about one-third, on the morning of the second day about two-thirds of the length of the tube, is excellently protected from being stolen by piercing the tube, of which some Apidæ, especially Hylocopa, are exceedingly fond. The flowers are placed nearly horizontally, the stamen a little above, the lip a little below a horizontal plain intersecting the entrance of the honey-tube. The lip, which in other species of Hedychium is expanded level and almost sessile, is here long stalked, and rolled up into a channel of 0·01 m. in length provided with a funnel-shaped entrance. The entrance of the lip-channel (Fig. 89 *A*) being about equally distant from the two longitudinal rows of anthers and stigmas Fig. 89 (*B*, *C*) between which it is situated, both rows are alike struck by the wings of the butterflies flying on and off.

The filament is 47 mm. long on the forenoon of the first day and somewhat bent upwards, so that the pollen-covered side of the anther looks outwards or even a little

[1] Continued from vol. xiii. p. 294.

upwards (hence the stigma looks upwards or even obliquely backwards); on the morning of the second day it is 50 mm. long, straight, and the stigma looking forwards; by the morning of the third day the flowers bend aside and wither. Consequently on the first day the anthers, on the second day the stigmas are more liable to be struck by the wings of the butterflies, although the stigmas seem to be capable of being pollinated already during the opening of the flower. The pistil, as in other species of Hedychium, is inclosed in a completely closed channel of the corolla tube (Fig. 90) and of the filament (Fig. 91); the funnel-shaped stigma (Fig. 92), secreting plenty of fluid and bordered with hairs (Fig. 93), slightly overtops the anther (Fig. 89, *st.*).

By the morning of the second day all bees and butterflies with a proboscis of more than 10 mm. long would be enabled to obtain at least a little portion of the very sweet honey from out the opening of the corolla-tube; whereas from the more conveniently situated opening of the lip-tube the full store of honey can be reached only by a single species of the butterflies of Itajahy (as far as their proboscides have been measured

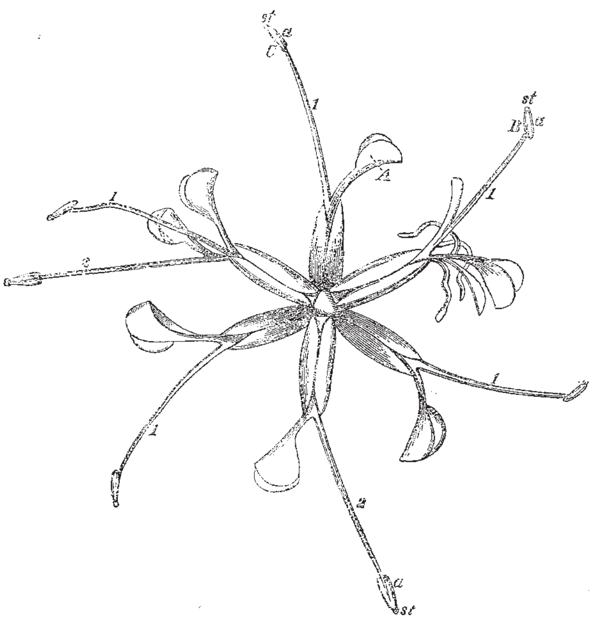

FIG. 89.—Hedychium. Two alternating whorls, each consisting of three groups, each group containing from four to six flowers, of which only one or two are developed. Half natural size. 1. Flowers on the first day. 4. Flowers on the second day. In most flowers only the lip and the stamen with the stigma are drawn. *a*, anther; *st*, stigma.

by my brother), namely, the males of *Callidryas Philea*, with a proboscis from 36 to 43 mm. long.[1]

This was indeed the most assiduous of all visitors. It was always sucking out of the lip. Scarcely less frequently were the flowers visited by *Callidryas Eubule* ♂, always sucking in the same way, with a proboscis from 27 to 30 mm. long (a female, caught on these flowers, had a proboscis only 24 mm. long). *Callidryas Trite* ♂, on the contrary, with a proboscis 18 to 20 mm. long, seems always to suck immediately out of the corolla-tube. *Callidryas Statira* ♂ (19 to 21 mm.) mostly sucks in the same way; but sometimes also from out the lip. *Callidryas Argante* being very rare during the flowering time of this Hedychium (towards the end of January) was only occasionally seen visiting its flowers, and it was not observed in what way it reached the honey. Dark yellow, orange, scarlet, red, are the favourite colours, not only of the Callidryas but likewise of the *Agraulis* (*Dione*) and of some species of *Papilio*; of the former, *Agraulis vanillæ* (proboscis 15 mm.) visited the flowers several times, but soon flew away again. Of species of Papilio, *P. Thoas* (26 mm.) appeared especially frequently, as also several times *P. Palydamas* (24-25 mm.), *P. Cleotas* (22-23 mm.) three times, and once *P. Protodamas* (?) (22 mm.); these mostly fluttered upwards along the rows of flowers without settling down; it was not distinctly seen from which opening they obtained the honey.

[1] The proboscis of the female seems to be not so long; in two females measured by my brother it did not exceed 35 mm.

Another adaptation of the flowers to cross-fertilisation by butterflies must be mentioned. A wing of a butterfly is a tolerably smooth plain, moving rapidly when flying; the pollen-grains of Hedychium are likewise smooth; these peculiarities are ill adapted to each other; but this inconvenience is removed by the anthers not bursting, but their anterior surface dissolving into a layer of slime which covers the pollen-grains and glues them to the wings.

Of Apidæ my brother once saw *Xylocopa*; it attempted to suck from the lip, but after having made some fruitless trials flew away again. He repeatedly met with *Bombus violaceus* and *Cayennensis*, rarely, however, compared with their frequent visits to other flowers, for instance, the neighbouring bushes of Buddleia. They sucked from out the corolla tube. *B. violaceus* was several times observed to alight on the lower flowers of a longitudinal row, climbing from there up the row more or less completely, then flying to another spike. In consequence of this systematic manner in which the most intelligent bees explore the flowers of a plant, the fertilisation by bees of a plant with such a number of flowers as our Hedychium

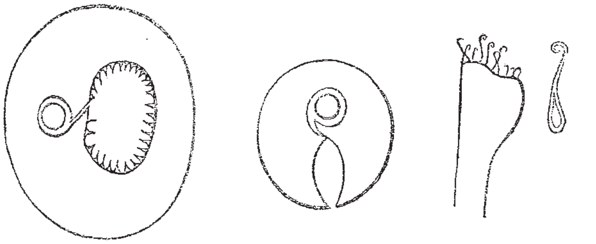

FIG. 90. FIG. 91. FIG. 92. FIG. 93.

FIG. 90.—Transverse section of the corolla-tube, 15 : 1. FIG. 91.—Transverse section of the filament enclosing the pistil. FIG. 92.—The stigma bordered with hairs. FIG. 93.—A single one of these hairs.

must be by far less advantageous than the fertilisation by butterflies. Suppose a specimen of this Hedychium bearing twenty spikes, each with fifty flowers, a humble-bee would be likely to visit 1,000 flowers without effecting a single cross-fertilisation between different plants, consequently without any profit for the plant, which is sterile with its own pollen. On the contrary, on flowers copiously visited by butterflies, the same butterfly will rarely visit a greater number of flowers of the same plant continuously; and this holds good, not solely, as Delpino has already remarked, with females which are followed by the males. On a Hedychium, males of Callidryas only were flying (females being then very rare), but, nevertheless, as soon as any butterfly was approached by another of the same or even of a different species, it flew up, ran and whirled with it about in the air, and then alighted commonly on another bush.

Lastly, there appeared repeatedly several species of humming-birds, one of which was so absorbed in sucking the honey that it could be caught with a net, which my brother had never before succeeded in doing. In the corolla-tube of this Hedychium small insects have never been found by my brother; the perseverance with which the humming-birds made use of its flowers proves, therefore, in case such a proof should still be needed, that these birds were here searching for honey.

It may be remarked in addition that humming-birds are far less exclusively attracted by the bright red colour of flowers than Callidryas; and, as these butterflies are

those which are found in greatest numbers in Itajahy (*Acræa Thalia* only perhaps equalling or even surpassing them in number), the frequent occurrence of orange-coloured or scarlet flowers in that country is probably less an adaptation to humming-birds than to this fondness of Callidryas. The red Salvia, Canna, the orange-coloured species of Lantana, *Epidendron cinnabarinum*, &c., are assiduously visited by Callidryas.

Lippstadt, May 13 HERMANN MÜLLER

LOAN COLLECTION OF SCIENTIFIC APPARATUS

SECTION—MECHANICS

PRIME MOVERS[1]

WE now come to Newcomen, who I think may fairly be looked upon as the father of the steam-engine in its present form. No. 1,942 is a model of his engine, which is further illustrated by a rare engraving (of 1712), the property of Mr. Bennet Woodcroft.

Here we have the steam boiler, the cylinder, the piston and rod, the beam working the pumps in the pit, the injection into the cylinder and the self-acting gear, making altogether a powerful and an automatic prime mover.

That conscientious writer, Belidor, to whom I have already frequently referred, says, that he hears of one of these machines having been set up in the water-works on the banks of the Thames at York Buildings. I may say to those who are not aware of it, that those works were situated where the Charing Cross Station now stands. On a Newcomen engine being erected in France at a colliery at Fresnes, near Condé, Belidor paid several visits to it in order that he might understand its construction thoroughly, and be thereby enabled to explain it to his readers. He has done so with a minuteness and faithfulness of detail, in description and in drawings, that would enable one to repeat the engine. This engine had a 30-inch cylinder with a 6-feet stroke of the piston and of the pumps. The boiler was 9 feet in diameter and $3\frac{1}{2}$ feet deep in the body; it had a dome which was covered with masonry 2 feet 6 inches thick to hold it down against the pressure of the steam. It had a safety valve (the Papin valve) which Belidor calls a "Ventouse," and says that its object was to give air to the boiler when the vapour was too strong. It had double vertical gauge cocks the function of which Belidor explains; it made fifteen strokes in a minute; and he says that being once started it required no attention beyond keeping up the fire, that it worked continuously for forty-eight hours, and in the forty-eight hours unwatered the mine for the week, whereas previously to the erection of the engine the mine was drained by a horse-power machine, working day and night throughout the whole week and demanding the labour of fifty horses and the attendance of twenty men to keep the water down. I should have said that the pumps worked by the steam-engine were 7 inches bore and were placed 24 feet apart vertically in the pit which was 276 feet deep, and that each pump delivered into a leaden cistern from which the pump above it drew.

After having given a most accurate description of the engine, Belidor breaks out into a rhapsody and says (I will give you a free translation) "It must be acknowledged that here we have the most marvellous of all machines, and that there is none other of which the mechanism has so close a relation to that of animals. Heat is the principal of its movements; in its various tubes a circulation like that of the blood in the veins is set up; there are valves which open and shut; it feeds itself, and it performs all other functions which are necessary to enable it to exist."

Smeaton employed himself in perfecting and in properly proportioning the Newcomen engine, but it was not until James Watt that the next great step was made; that step was as we all know the doing away with condensation in the cylinder, the effecting it in a separate vessel and the exclusion of the atmosphere from the cylinder. These alterations made a most important improvement in the efficiency of the engine in relation to the fuel consumed; but they were so simple that I doubt not if examiners into the merits of patents had existed in those days Mr. Watt would have had his application for a patent rejected as being "frivolous." We have here from case No. 1,928, a model made by Watt which appears to be that of the separate condenser and air-pump; we have also 8B which is a wooden model made by Watt of a single acting inverted engine, having the top side of the cylinder always open to the condenser, and a pair of valves by which the bottom side of the piston can be put into alternate connection with the boiler and with the condenser, the contents of which are withdrawn by the air-pump. 3B from the same case is a model of a direct acting inverted pumping engine, made in accordance with the diagram 8B. 1B is a model of Watt's single acting beam pumping engine, while 2B is a model of Watt's double acting beam rotary engine. 10B from the same case is Watt's model of a surface condenser. To Watt we owe, condensation in a separate vessel, exclusion of the air from the cylinder, making the engine double acting, employment of the steam jacket, and employment of the steam expansively, the parallel motion, the governor, and in fact all which made Newcomen's single acting reciprocating pumping engine into that machine of universal utility that the steam-engine now is, and not only so, but Watt invented the steam-engine indicator which enables us to ascertain that which is taking place within the cylinder and to see whether or not the steam is being economically employed. I have on the table before me a very excellent model of German manufacture, No. 2,137, illustrating an inverted direct acting pumping engine in its complete form, and I have also a model of French manufacture, the cylinder and other working parts of which are in glass; this shows a form of Watt rotary beam condensing engine at one time in common use.

I do not say, however, that Watt was the first to make the suggestion of attaining rotary motion from the power of steam. Leaving out of consideration Hero's toy, Papin, as I have remarked, hoped to get rotary movement second-hand by working a water wheel with the water that had been raised by his steam-engine; moreover, as early as 1737, Jonathan Hulls proposed to obtain rotary motion from a Newcomen engine and to employ that motion in turning a paddle-wheel, to propel a tug-boat which should tow ships out of harbour, or even against an adverse wind. I have before me one of the prints of his pamphlet and in order that you may better appreciate his invention I have put an enlarged diagram upon the wall, and I think I may take this as the starting-point for saying a few words about the steam-engine as a prime mover in steam vessels.

We have in the collection, No. 2,150, Symington's engine tried upon the Lake at Dalswinton in 1788. Here a pair of single acting vertical cylinders give, by the up and down motion of their pistons, reciprocating movement to an overhead wheel; this wheel gives a similar motion to an endless chain which chain is led away so as to pass round two pairs of ratchet wheels loose upon two paddle shafts. By the use of a pair of ratchets the reciprocations of the chain are converted into rotary motion in one direction only, and that the driving direction of the two paddle wheels placed one behind the other. Symington's arrangement for obtaining the rotary motion always in one direction of his two paddle-wheels is very similar to that proposed by Jonathan Hulls for his single stern-wheel. Want of time forbids me to do more than just to allude to the names of Hornblower and Wolff in connection with double cylinder engines, engines wherein the expansion of steam is commenced in one cylinder and continued in another and a larger one.

I wish to say a few words which will bring before you the changes that have been made within a very few years in the construction of the marine engines. I may observe that when I was an apprentice the ordinary working pressure of steam, except in the double cylinder engine, was only 3 lbs. above atmosphere, and that there was in a marine boiler more pressure on its bottom when the steam was down, due to the mere head of water in the boiler, than there was pressure in the top when the steam was up, due to the force of the steam; whereas now condensing marine engines work commonly at 70 lbs., and there is a boat under trial where the steam is, I believe, as high as 400 lbs.

To those who are curious on the subject, I would recommend a perusal of two blue books, one being the evidence taken before a Parliamentary Commission in 1817, and the other before a Parliamentary Committee in 1839; they will find there the weight of evidence to be that the only use of high pressure steam is to dispense with condensing water, and that as a steamboat must always have plenty of condensing water in its neighbourhood, no engineer knowing his business, would suggest high pressure for a marine engine.

I have before me a model of a pair of engines which, although

[1] Address delivered by F. J. Bramwell, C.E., F.R.S., one of the vice-presidents of the Section, May 25. Continued from p. 161.